Product Overview

The Cisco MDS 9000 Family of multilayer directors and fabric switches offer intelligent fabric-switching services that realize maximum performance while ensuring high reliability levels. They combine robust and flexible hardware architecture with multiple layers of network and storage management intelligence. This powerful combination enables highly available, scalable storage networks that provide advanced security and unified management features.

The Cisco MDS 9000 Family provides intelligent networking features such as multiprotocol and multitransport integration, virtual SANs (VSANs), advanced security, sophisticated debug analysis tools, and unified SAN management.

This chapter lists the hardware features for the Cisco MDS 9000 Family and describes its software features. It includes the following sections:

Hardware Overview

This section provides an overview of the Cisco MDS 9000 Family of multilayer directors and fabric switches.

- Cisco MDS 9216 multilayer fabric switches contain one fixed integrated supervisor module with 16 Fibre Channel ports and an expansion slot which can support up to 32 additional ports (for a total of 48 ports).
- Cisco MDS 9509 multilayer directors contain two slots for supervisor modules and 7 slots for switching or services modules providing up to 224 ports (32 ports x 7 slots).
- Cisco MDS 9506 multilayer directors contain two slots for supervisor modules and 4 slots for switching or services modules providing up to 128 ports (32 ports x 4 slots).
- Cisco MDS 9140 multilayer switches contains 40 s (8 full rate ports, 32 oversubscribed ports)
- Cisco MDS 9120 multilayer switches contains 20-port (4 full rate ports, 16 oversubscribed ports)

Cisco MDS 9216 Fabric Switch

Cisco MDS 9216 fabric switches share a consistent software architecture with the Cisco MDS 9500 Series in a semi-modular chassis. They consist of the following major hardware components:

- The chassis has two slots, one of which is reserved for the supervisor module. The supervisor module provides supervisor functions and has 16 standard, Fibre Channel ports.
- The backplane has direct plug-in connectivity to one switching module (any type).
- Two redundant, hot-swappable power supplies have AC connections, each of which can supply power to a fully loaded chassis.
- The hot-swappable fan module has four fans managing the airflow and cooling for the entire switch.
- The 1-Gbps or 2-Gbps autosensing Fibre Channel ports support Inter-Switch Links (E ports), extended Inter-Switch Links (TE ports), loop (FL and TL ports), and fabric (F ports) connectivity. Besides Telnet access, a 10/100BASE-T Ethernet port provides switch access and a RS-232 (EIA/TIA-232) serial port allows switch configuration.
- Hot-swappable, small form-factor pluggable (SFP) ports can be configured with either short or long wavelength SFPs for connectivity up to 500m and 10km, respectively. Additionally, all ports are configurable for both FCIP and iSCSI operation on a port-by-port basis. Ports configured for FCIP operation can be further configured to support up to three virtual ISL connections.

Refer to the *Cisco MDS 9200 Series Hardware Installation Guide*.

Cisco MDS 9500 Modular Directors

The Cisco MDS 9500 Series includes two multilayer, modular directors:

- The C Cisco MDS 9509 Director addresses the stringent requirements of large data center storage environments and consists of the following major hardware components:
  - The chassis has nine slots, two of which are reserved for the supervisor modules.
  - Up to seven hot-pluggable switching or services modules that provide Fibre Channel or Gigabit Ethernet services.
  - The backplane has direct plug-in connectivity to seven switching modules, two integrated supervisor modules, two clock modules, and two power supplies.
  - The hot-swappable fan module has nine fans managing the airflow and cooling for the entire switch.
- The Cisco MDS 9506 Director addresses the stringent requirements of data center storage environments and consists of the following major hardware components:
  - The chassis has six slots, two of which are reserved for the supervisor modules.
  - Up to four hot-pluggable switching or services modules that provide Fibre Channel or Gigabit Ethernet services.
  - The backplane has direct plug-in connectivity to four switching modules, two integrated supervisor modules, two clock modules, and two power supplies.
  - The hot-swappable fan module has six fans managing the airflow and cooling for the entire switch.

These modular directors have the following features:

- Two redundant, hot-swappable power supplies have AC or DC connection, each of which can supply power to the entire chassis.
- Two supervisor modules ensure high availability and traffic load balancing capabilities. Each supervisor module can control the entire switch. The standby supervisor module provides redundancy in case the active supervisor module fails.
- The 1-Gbps or 2-Gbps autosensing Fibre Channel ports support Inter-Switch Links (E ports), Extended Inter-Switch Links (TE ports), loop (FL and TL ports), and fabric (F ports) connectivity. Besides Telnet access, a 10/100BASE-T Ethernet port provides switch access and a RS-232 serial port allows switch configuration.
- Hot-swappable, small form-factor pluggable (SFP) ports can be configured with either short or long wavelength SFPs for connectivity up to 500m and 10km, respectively. Additionally, all ports are configurable for both FCIP and iSCSI operation on a port-by-port basis. Ports configured for FCIP operation can be further configured to support up to three virtual ISL connections.

Refer to the *Cisco MDS 9500 Series Hardware Installation Guide*.

Cisco MDS 9100 Series Fixed Configuration Fabric Switches

Cisco MDS 9100 Series includes two multilayer, fixed configuration (non-modular) switches:

- The Cisco MDS 9140 is a 40-port (8 full rate ports, 32 oversubscribed ports)
- The Cisco MDS 9120 is a 20-port (4 full rate ports, 16 oversubscribed ports)

These fixed configuration switches are packaged in a 1 RU enclosures and have the following features:

- Two redundant, hot-swappable power supplies have AC connections, each of which can supply power to the entire chassis.
- Two hot-swappable fan modules with two fans each manage the airflow and cooling for the entire switch.
- The 1-Gbps or 2-Gbps autosensing Fibre Channel ports support Inter-Switch Links (E ports), Extended Inter-Switch Links (TE ports), loop (FL and TL ports), and fabric (F ports) connectivity. Besides Telnet access, a 10/100BASE-T Ethernet port provides switch access.
- Hot-swappable, small form-factor pluggable (SFP) ports can be configured with either short or long wavelength SFPs for connectivity up to 500m and 10km, respectively.

Note Switches in the Cisco MDS 9100 Series do not have a COM1 port.

Refer to the *Cisco MDS 9100 Series Hardware Installation Guide*.

Software Features

This section provides an overview of the major software features of the Cisco MDS 9000 Family of multilayer directors and fabric switches.

High Availability

The Cisco MDS 9500 Series of multilayer directors support application restartability and nondisruptive supervisor switchability. The switches are protected from system failure by redundant hardware components and a high availability software framework. The high availability (HA) software framework includes the following:

- Provides stateful redundancy for supervisor module failure by using dual supervisor modules.
- Ensures nondisruptive software upgrade capability. See Chapter 5, "Software Images."
- Protects against link failure using the PortChannel (port aggregation) feature. See Chapter 11, "Configuring PortChannels." This feature is also available in Cisco MDS 9216 switches and in the Cisco MDS 9100 Series.
- Provides management redundancy using Virtual Routing Redundancy Protocol (VRRP). See the "Configuring VRRP" section on page 17-18. This feature is also available in Cisco MDS 9216 switches and in the Cisco MDS 9100 Series.
- Performs nondisruptive restarts of a failed process on the same supervisor module. A service running on the supervisor modules and on the switching module tracks the HA policy defined in the configuration and takes action based on this policy. This feature is also available in Cisco MDS 9216 switches and in the Cisco MDS 9100 Series.

See Chapter 4, "Configuring High Availability."

Switch Reliability

Switches in the Cisco MDS 9000 Family maintain internally controlled reliability services that ensure continued service with no degradation. This reliability service includes the following:

- Provides power-on self testing (POST)
- Detects errors, isolates faults, performs parity checking, and checks illegal addresses
- Enables remote diagnostics using Call Home troubleshooting features
- Displays LEDs that summarize the status of each switching module, supervisor module, power supply, and fan assembly

Virtual SANs

VSANs (virtual SANs) enable higher security and greater scalability in Fibre Channel fabrics. VSANs provide isolation among devices that are physically connected to the same fabric. VSANs allow multiple logical SANs over a common physical infrastructure. VSANs offer the following:

- Traffic isolation—Traffic is contained within VSAN boundaries and devices reside only in one VSAN thus ensuring absolute separation between user groups, if desired.
- Scalability—VSANs are overlaid on top of a single physical SAN. The ability to create several logical VSAN layers increases the scalability of the SAN.
- Per VSAN fabric services—Replication of fabric services on a per VSAN basis provides increased scalability and availability.
- Redundancy—Several VSANs created on the same physical SAN ensure redundancy. If one VSAN fails, redundant protection is provided by a configured backup path between the host and the switch.
- Ease of configuration—Users can be added, moved, or changed between VSANs without changing the physical structure of a SAN. Moving a device from one VSAN to another only requires configuration at the port level, not at a physical level.

See Chapter 8, “Configuring and Managing VSANs.”

Intelligent Zoning

Zoning controls access between devices in a VSAN. Zoning accomplishes the following:

- Partitions devices that use different operating systems. In a heterogeneous environment, it is often necessary to separate servers and storage devices to avoid accidental transfer of information between devices with different operating systems. Such transfers could result in corruption or deletion of data.
- Creates logical subsets of closed user groups. Closed user groups are needed to enforce security or to separate functional areas across the fabric.
- Configures groups of devices that are separate from the rest of the fabric. Based on the assigned zone membership, devices outside the zone cannot access devices internal to the zone.
- Provides temporary access between devices (zone sets). Zone restrictions can be imposed temporarily, and then restored to revert to normal operation, if desired.
- Restricts access to specific logical unit numbers (LUNs) associated with a device.
- Allows zone members to have only read-only access to the media within a read-only Fibre Channel zone.

See Chapter 12, “Configuring and Managing Zones” and the “VSANs Versus Zones” section on page 8-4.

Trunking

Trunking is the term used to refer to an ISL link that carries one or more VSANs. Trunking ports receive and transmit Extended ISL (EISL) frames. EISL frames carry an EISL header containing VSAN information. Once EISL is enabled on an E port, that port becomes a TE port (see Chapter 9, "Configuring Interfaces," and Chapter 10, "Configuring Trunking"). The trunking configuration is saved along with the interface information.

See the "About PortChanneling and Trunking" section on page 11-3.

PortChannels

PortChannel refers to the aggregation of multiple physical Fibre Channel ports into one logical port to provide high aggregated bandwidth, load balancing, and link redundancy. Up to 16 physical ports can be aggregated into a PortChannel. PortChannels can connect to ports across switching modules. The failure of a port in one switching module does not bring down the logical PortChannel link. Specifically, a PortChannel does the following:

- Increases the aggregate bandwidth on an ISL or EISL by distributing traffic among all functional links in the channel.
- Load balances across multiple links and maintains optimum bandwidth utilization. Load balancing is based on a source ID (SID), destination ID (DID), and optionally the originator exchange ID (OX ID) that identify the flow of the frame.
- Provides high availability on an ISL. If one link fails, traffic previously carried on this link is switched to the remaining links. If a link goes down in a PortChannel, the upper protocol is not aware of it. To the upper protocol, the link is still there, although the bandwidth is diminished. The routing tables are not affected by link failure. PortChannels can contain up to 16 physical links and can span multiple modules for added high availability.

See Chapter 11, "Configuring PortChannels."

IP Services

Switches in the Cisco MDS 9000 Family support the following IP services:

- IP over Ethernet —These services are limited to management traffic.
- IP over Fibre Channel (IPFC)—IPFC (RFC 2625) specifies how IP packets are transported using encapsulation schemes. By encapsulating IP frames into Fibre Channel frames, management information is exchanged among switches without requiring a separate Ethernet connection to each switch. Each switch includes:
  - Encapsulation for IP and Address Resolution Protocol (ARP) over Fibre Channel.
  - Address resolution uses the ARP server.
- IP routing services—These services include:
  - Ethernet or TCP/IP connection.
  - Static IP routing services to enable management traffic between VSANs.
  - DNS client support.
  - The Network Time Protocol (NTP) server synchronizes the system clocks of network devices.

See Chapter 17, "Configuring IP Services."

IP Storage

The Cisco MDS 9000 Family IP services module integrates seamlessly into the Cisco MDS 9000 Family of Multilayer Directors and Fabric Switches. Traffic can be routed between any IP storage port and any other port on a Cisco MDS 9000 Family switch. The Cisco MDS 9000 Family IP Storage Services Module supports the full range of services available on other MDS 9000 Family Switching Modules including VSANs, security, and traffic management. It uses widely known IP to cost-effectively connect to more servers and more locations over greater distances than previously possible. It delivers both Fibre Channel over IP (FCIP) and iSCSI IP storage services and is configurable on a port-by-port basis.

- FCIP highlights
  - Simplifies data protection and business continuance strategies by enabling backup, remote replication, and disaster recovery over WAN distances using open-standard FCIP tunneling.
  - Improves utilization of WAN resources for backup and replication by tunneling up to 3 virtual Inter Switch Links (ISLs) on a single Gigabit Ethernet port.
  - Reduces SAN complexity by eliminating the need to deploy and manage a separate remote connectivity platform.
  - Preserves Cisco MDS 9000 Family enhanced capabilities including VSANs, advanced traffic management, and security across remote connections.
- iSCSI highlights
  - Extends the benefits of Fibre Channel SAN-based storage to IP-enabled servers at a lower cost point than possible using Fibre Channel interconnect alone.
  - Increases storage utilization and availability through consolidation of IP and Fibre Channel block storage.
  - Transparent operation preserves the functionality of legacy storage applications such as zoning tools.
  - Extending the Benefits of Fibre Channel SANs

See Chapter 18, “Configuring IP Storage.”

Call Home

The Call Home feature detects switch failures and sends alerts along with relevant failure information. These alerts are sent through E-mail to a user-specified customer center.

See Chapter 19, “Configuring Call Home.”

QoS and Congestion Control

Switches in the Cisco MDS 9000 Family provide priority queuing and flow control services.

- Priority queuing—The switches provide low and high priority quality of service (QoS) queues. While time-critical traffic is marked as high priority traffic, all other traffic is assigned to the default low priority queue.
- Fibre Channel Congestion Control (FCC)—FCC is a flow control mechanism that alleviates congestion on Fibre Channel networks. Any switch in the network can detect congestion for an output port. The switches sample frames from the congested queue and generate messages about the congestion level upstream toward the source of the congestion. The switch closest to the source, with FCC enabled, can perform one of two actions:
  - Forwards the frames as other vendor switches do.
  - Limits the flow of frames from the port causing the congestion.

See Chapter 21, “Configuring Traffic Management.”

SPAN and RSPAN

The switched port analyzer (SPAN) feature is specific to switches in the Cisco MDS 9000 Family. It monitors network traffic though a Fibre Channel interface. Traffic through any Fibre Channel interface can be replicated to a special port called the SPAN destination port (SD port). Any Fibre Channel port in a switch can be configured as an SD port. Once an interface is in SD-port mode, it cannot be used for normal data traffic. You can attach a Fibre Channel Analyzer to the SD port to monitor SPAN traffic.

See Chapter 24, “Monitoring Network Traffic Using SPAN” and the “Configuring a Fabric Analyzer” section on page 25-6).

The Remote SPAN (RSPAN) feature enables you to remotely monitor traffic for one or more SPAN sources distributed in one or more source switches in a Fibre Channel fabric. The SPAN destination (SD) port is used for remote monitoring in a destination switch. A destination switch is usually different from the source switch(es) but is attached to the same Fibre Channel fabric. You can replicate and monitor traffic in any remote Cisco MDS 9000 Family switch or director, just as you would monitor traffic in a MDS source switch. This feature is nonintrusive and does not affect network traffic switching for any SPAN source ports.

See the “Remote SPAN” section on page 24-14.

Switch Management Features

Besides the software features already listed, there are additional management features that fall into the following categories: redundant supervisor module management, fabric management, and security management

Redundant Supervisor Module Management

Series of multilayer directors support two redundant supervisor modules. They require two supervisor modules to enforce redundant supervisor module management and high availability and restartability (see Table 1-1).

Table 1-1 Supervisor Module Options in Cisco MDS 9000 Switches

Product	No. of Supervisor Modules	Slot	Features
Cisco MDS 9216	One module (includes 16 Fibre Channel ports)	Slot 1	2-slot chassis allows one optional switching module in the other slot.
Cisco MDS 9506	Two modules	Slots 5 and 6	6-slot chassis allows any switching module in the other four slots.
Cisco MDS 9509	Two modules	Slots 5 and 6	9-slot chassis allows any switching module in the other seven slots.
Cisco MDS 9140	Not applicable.		
Cisco MDS 9120	Not applicable.		

When the switch powers up and both supervisor modules are present, the module in slot 5 enters the active mode, while the second module in slot 6 enters the standby mode. All storage management functions occur on the active supervisor module. The standby module constantly monitors the active module. If the active module fails, the standby module takes over without any impact to user traffic.

Refer to the *Cisco MDS 9500 Series Hardware Installation Guide*.

Fabric Management

Switches in the Cisco MDS 9000 Family offer fabric management and control through the command-line interface (CLI) by using Telnet, SSH, or a serial console and through the Cisco MDS 9000 Fabric Manager tool by using the Simple Network Management Protocol (SNMP) services:

- SNMP versions 1, 2, and 3 are supported.
- Remote Monitoring (RMON) allows you to specify thresholds and monitor alarms on SNMP variables. Extended RMON alarms are available for supported Management Information Base (MIB) objects (refer to the *Cisco MDS 9000 Family MIB Reference Guide*).
- System error message logs (syslogs) are viewed through a console or Telnet session for asynchronous events such as an interface transition. Syslogs are directed to a local buffer or to an external server and are provisioned using the CLI or the Cisco Fabric Manager GUI (refer to the *Cisco MDS 9000 Family System Messages Guide)*.

See the "CLI" section on page 1-11, the "Cisco MDS 9000 Fabric Manager" section on page 1-11, and the "SNMP Security" section on page 14-22.

Security Management

The Cisco MDS 9000 Family of switches offer strict and secure switch management options through switch access security, port security, user authentication, and role-based access.

See Chapter 14, "Configuring System Security and AAA Services."

Switch Access Security

Each switch can be accessed through the CLI or SNMP.

- Secure switch access—Available when you explicitly enable Secure Shell (SSH) access to the switch. SSH access provides additional controlled security by encrypting data, user IDs, and passwords. By default, Telnet access is enabled on each switch.

- SNMP access—SNMPv3 provides built-in security for secure user authentication and data encryption.
- IP Access control lists (IP-ACLs)—Provide basic network security to all switches in the Cisco MDS 9000 Family. IP-ACLs restricts IP-related inband traffic based on IP addresses (layer 3 and layer 4 information). You can use IP-ACLs to control transmissions on an interface.

Port Security

Port security features prevent unauthorized access to a switch port in the Cisco MDS 9000 Family.

- Login requests from unauthorized Fibre Channel devices (Nx ports) and switches (xE ports) are rejected.
- All intrusion attempts are reported to the SAN administrator through syslog messages.

User Authentication

A strategy known as authentication, authorization, and accounting (AAA) is used to verify the identity of, grant access to, and track the actions of remote users. The Remote Access Dial-In User Service (RADIUS) protocol provides AAA solutions.

Based on the user ID and password combination provided, switches perform local authentication using a local database or remote authentication using the RADIUS server(s). A global, preshared, secret key authenticates communication between the RADIUS client and server. This secret key can be configured for all RADIUS servers or for only a specific RADIUS server. This kind of authentication provides a central configuration management capability.

Role-Based Access

Role-based access assigns roles or groups to users and limits access to the switch. Access is assigned based on the permission level associated with each user ID. Your administrator can provide complete access to each user or restrict access to specific read and write levels for each command.

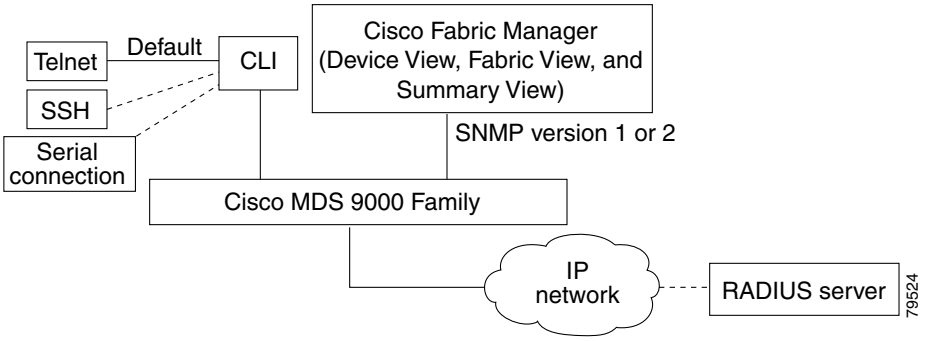
From Release 1.2(x), CLI and SNMP in all switches in the Cisco MDS 9000 Family use the common roles database. This database contains any role that is created using CLI or SNMP. You can use SNMP to modify a role that was created using CLI and vice versa. Each role in SNMP is the same as a role created or modified through the CLI.

Each role in the Common Role database can be restricted to one or more VSAN as required.

Tools for Software Configuration

You can use one of two configuration management tools to configure your SANs: the CLI and the Cisco MDS 9000 Fabric Manager graphical user interface (GUI) from your browser (see Figure 1-1).

Figure 1-1 Tools for Configuring Software



CLI

With the CLI, you can type commands at the switch prompt, and the commands are executed when you press the Enter key. The CLI parser provides command help, command completion, and keyboard sequences that allow you to access previously executed commands from the buffer history.

Cisco MDS 9000 Fabric Manager

The Cisco Fabric Manager is a Java and SNMP-based network fabric and device management tool with a GUI that displays real-time views of your network fabric and installed devices. The Cisco Fabric Manager provides three views for managing your network fabric:

- The Device View displays a continuously updated physical picture of device configuration and performance conditions for a single switch.
- The Fabric View displays a view of your network fabric, including multiple switches.
- The Summary View presents a summary view of switches, hosts, storage subsystems, and VSANs.

The Cisco Fabric Manager provides an alternative to the CLI for most switch configuration commands. The Cisco Fabric Manager is bundled with each switch in the Cisco MDS 9000 Family.

Refer to the *Cisco MDS 9000 Fabric Manager User Guide*.

Note Resource Manager Essentials (RME) versions 3.4 and 3.5 provide support for switches in the Cisco MDS 9000 Family. Patches are available on Cisco Connection Online (http://www.cisco.com/).